AP Biology, Semester 1
Unit Quiz: The Gene
Instructor Version

Section I: Multiple-Choice Questions

Answer Sheet

1.	B
2.	E
3.	C
4.	C
5.	D
6.	C
7.	A
8.	B
9.	D
10.	D

11.	A
12.	E
13.	B
14.	D
15.	D
16.	C
17.	D
18.	B
19.	A
20.	D

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Section II: Free-Response Questions

Time Limit: You have 30 minutes to complete this section. Both questions are weighted equally, so allow around 15 minutes for each question. You may move back and forth between questions until time is called.

Scoring: 20 points each, 40 points total

Directions: Answer each of the questions in essay form. Outline form is not acceptable. Labeled diagrams may be used to supplement your answer, but a diagram alone is insufficient. Read each question carefully before you begin to write your answer.

Note - the student's answers should be in prose form, not outline form; tables are presented here to assist grader in identifying important elements of each answer.

1. The processes of DNA replication, transcription, and translation all take advantage of the specific base-pairing nature of DNA and RNA nucleotides.

   Explain how the nitrogenous bases pair, and discuss why the specific base pairing nature of DNA and RNA nucleotides is essential for the processes of DNA replication, transcription and translation.

   ANSWER:

	DNA replication	**Transcription**	**Translation**
Base pairing	adenine with thymine guanine with cytosine hydrogen bonds hold complementary bases together	adenine with uracil guanine with cytosine	adenine with uracil guanine with cytosine
How structure is essential for function	Because the bases always pair in the same way, the two strands in a double-stranded DNA molecule are complementary. Thus, one double-stranded DNA molecule can be used to make two identical double-stranded DNA molecules by copying each strand independently. Since bases are held together by hydrogen bonds, the two strands can separate without disrupting the chemical structure of either strand	Because the bases always pair in the same way, one strand of DNA is used as a template for making RNA. The RNA will be complementary to the template strand. The RNA strand has the same information the template DNA strand had, only in a slightly different form.	Because the bases always pair in the same way, the anticodon on the tRNA will only pair with the correct codon on the mRNA. This assures that the correct amino acid is added to the growing polypeptide.

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2. Advances in biotechnology have made it possible to manipulate the DNA present in an organism.

   Explain the steps you would take to introduce a gene of interest into a bacterial cell, and state the purpose of each step. How would you select for bacteria that contain the gene of interest? Give an example of a practical application for this technology.

   ANSWER:

   1. Design plasmid

Component	**Purpose**
origin of replication	so the plasmid can be replicated
ampicillin resistance gene	used to select bacteria that contain the plasmid
the gene of interest inserted into the middle of the *β-galactosidase* gene	when grown in presence of X-gal, white colonies do contain gene of interest, while blue colonies don't contain the gene of interest. β-galactosidase breaks down X-gal to form a molecule that makes the colonies blue. If the gene is interrupted, the X-gal is not broken down.

   2. Perform a bacterial transformation with three samples

Sample	**Purpose**
Plasmid designed in step 1	experimental group (this is what we want to get into the bacteria)
No plasmid	negative control (to show it is possible to get a negative result)
Plasmid that has previously been used successfully to transform bacteria	positive control (to show the transformation procedure worked properly)

Step	**Purpose**
Heat shock: Add sample DNA to competent *E. coli* cells on ice. Place mixture at 42°C for 45 seconds. Place mixture back on ice.	To make the cells pick up the plasmid DNA.
Plate the cells out on plates with nutrient agar containing the X-gal molecule and the antibiotic ampicillin. Grow overnight at 37°C.	Select for bacteria that have picked up the plasmid. Only those with the plasmid will be able to grow in the presence of ampicillin.

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Look at controls.	Negative control should have no colonies because no plasmid was added and all bacteria should be sensitive to ampicillin. Positive control should have lots of colonies because the plasmid is known to be able to confer ampicillin resistance to bacteria in a transformation experiment.
Select a white colony.	Only white colonies have picked up a plasmid that contains the gene of interest. Since the gene of interest was inserted into the *β-galactosidase* gene, colonies with the gene of interest can't break down X-gal.

3. One possible practical application is to produce a large quantity of a protein for pharmaceutical uses. For example, a plasmid engineered to contain the genes necessary for insulin production could be used to produce insulin to treat diabetics.

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